IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

M07/4/BIOLO/HP3/ENG/TZ1/XX+

22076009

BIOLOGY
HIGHER LEVEL
PAPER 3

Tuesday 15 May 2007 (morning)

1 hour 15 minutes

Candidate session number

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INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your session number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the candidate box on your cover sheet and indicate the number of answer sheets used in the appropriate box on your cover sheet.

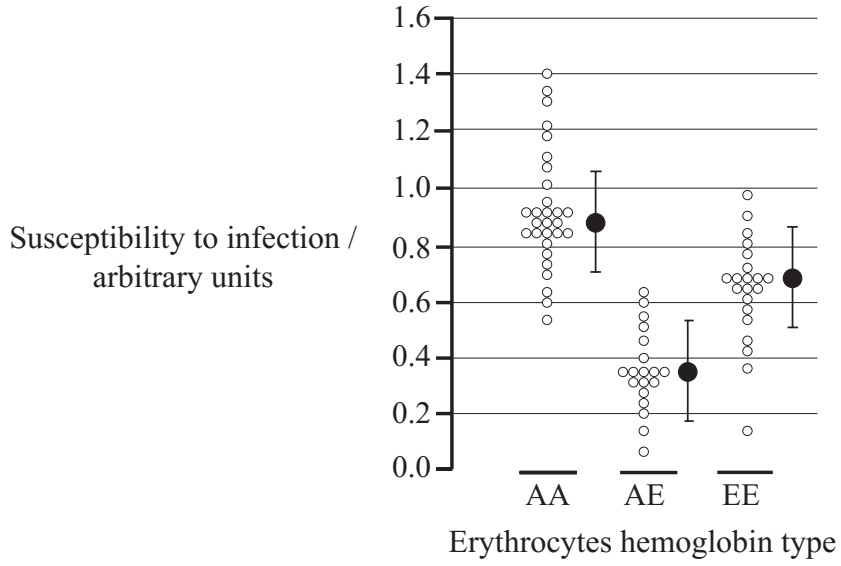
0121

Option D — Evolution

D1. Hemoglobin E, common in South-East Asia, was formed by a single point mutation of the gene for normal hemoglobin A. Its possible protective mechanisms against malarial parasites (*Plasmodium falciparum*) were assessed. An experiment was carried out on red blood cells (erythrocytes) with different types of hemoglobin. The erythrocytes with hemoglobin A and hemoglobin E were mixed with malarial parasites allowing infection to take place. The susceptibility to infection gives an idea of how easily the malarial parasite can infect the cells (the higher the value, the easier it is infected).

The graph shows the susceptibility to infection by malaria of erythrocytes with different hemoglobin types and their median value represented by ●.

Key:
AA: homozygous normal hemoglobin A
AE: heterozygous normal hemoglobin A and abnormal hemoglobin E
EE: homozygous abnormal hemoglobin E



[This research was originally published in *Blood*. Source: Kesinee Chotovanich, "Hemoglobin E: a balanced polymorphism protective against high parasitemias and thus severe P falciparum malaria", *Blood,* 2002, **100** (4), pages 1172–1176, © the American Society of Hematology]

(a) Identify the median susceptibility to infection for erythrocytes with homozygous hemoglobin A. *[1]*

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(b) Identify the greatest susceptibility to infection for heterozygous erythrocytes. *[1]*

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(This question continues on the following page)

(Question D1 continued)

(c) Compare the data shown in the graph for heterozygous AE with homozygous EE erythrocytes. *[2]*

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(d) Using the results of this experiment, explain how a balanced polymorphism of the gene for hemoglobin could be maintained in a human population. *[3]*

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D2. (a) Complete the table to compare the size of some features of hominid fossils (no values required). *[2]*

Feature	***Australopithecus africanus***	***Homo erectus***
Molars		
Brain		

(b) State **one** method for dating these fossils. *[1]*

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D3. (a) In 1923 Alexander Oparin suggested that the atmosphere of the pre-biotic Earth was not as we know it today. Outline the conditions that are thought to have existed in pre-biotic Earth. *[4]*

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(b) Explain the theory of evolution by natural selection. *[6]*

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Option E — Neurobiology and Behaviour

E1. (a) Outline the causes and symptoms of Parkinson's disease. *[4]*

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(b) Explain the importance of innate and learned behaviour in the survival of animals, using **named** examples of both types of behaviour. *[6]*

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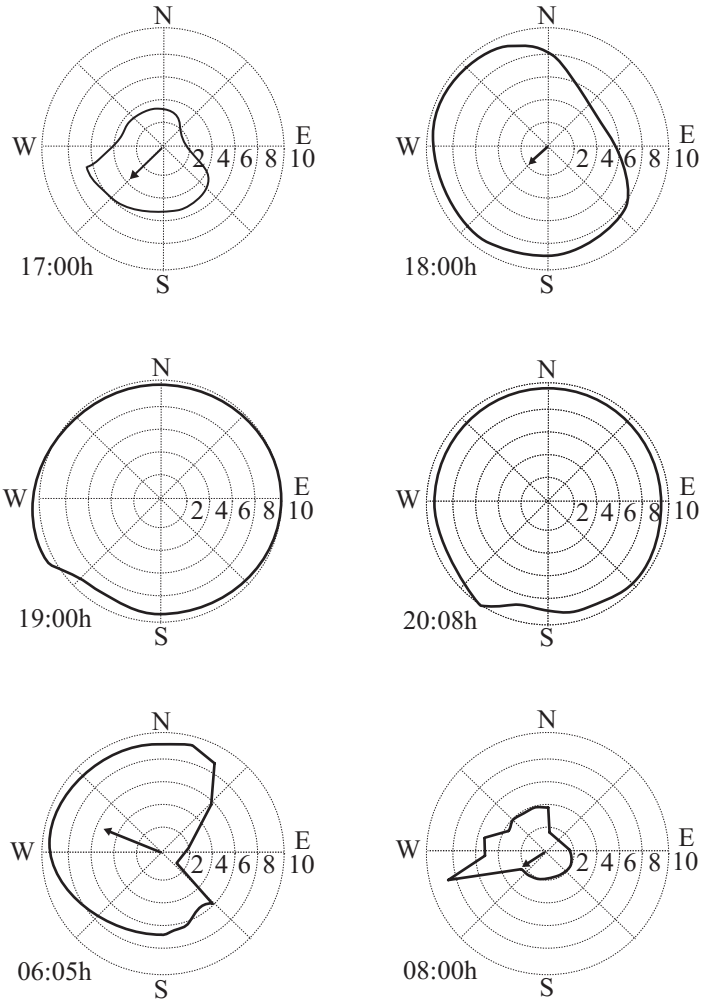
E2. Many animal species use long-range calls to establish their use of space and their relationships with members of their own and other species. Most of the calls of the African Savanna elephant (*Loxodonta africana*) are below the range of human hearing. The area in which the elephants can detect the calls is known as the calling area. On any given day, the calling area undergoes expansions and contractions. The diagrams below show the calling area (solid line) of elephants in the Etosha National Park at different times of the day. The position of the calling elephants is the centre of the diagram. Circular rings depict distance (in km). The wind speed (in $m\,s^{-1}$) and direction are shown with an arrow. If there is no arrow on the diagram it shows there was no wind.



[Source: D Larom, *et al.*, *Journal of Experimental Biology* (1997), **200**, pages 421–431, Reprinted with the permission of the Company of Biologists]

(a) Identify the time of the day when the calling area was greatest. *[1]*

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(b) Identify the wind speed at 08:00h. *[1]*

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(This question continues on the following page)

(Question E2 continued)

(c) Compare the calling area at 17:00h with 18:00h. *[2]*

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(d) Discuss the relationship between the wind and the calling area. *[3]*

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E3. (a) State the name of the human sensory receptors which detect heat. *[1]*

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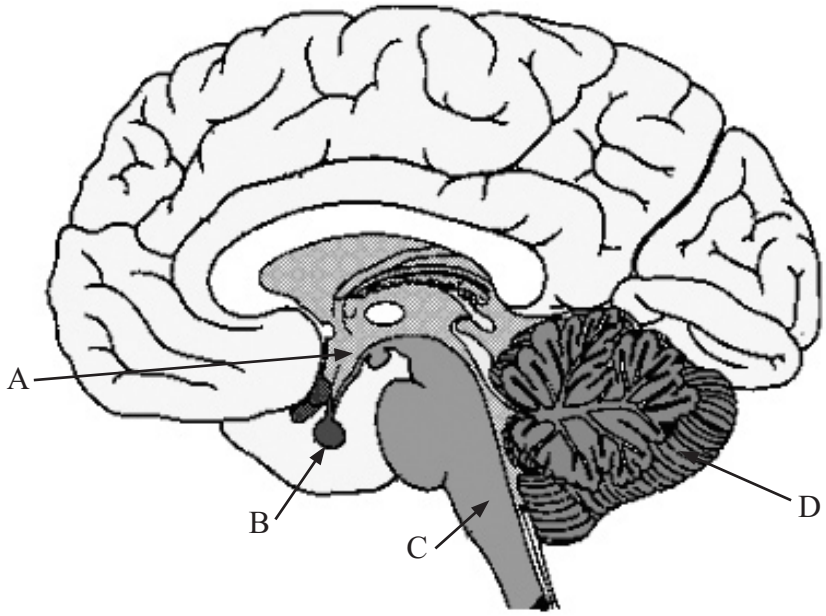
(b) Identify the structures labelled below. *[2]*



[Source: Neuroscience for kids, *The Brain, Right Down the Middle (Midsaggital Plane*), http://faculty.washington.edu/chudler/neurok.html, used with permission of Dr Eric H Chudler]

A: . . . . . .

B: . . . . . .

C: . . . . . .

D: . . . . . .

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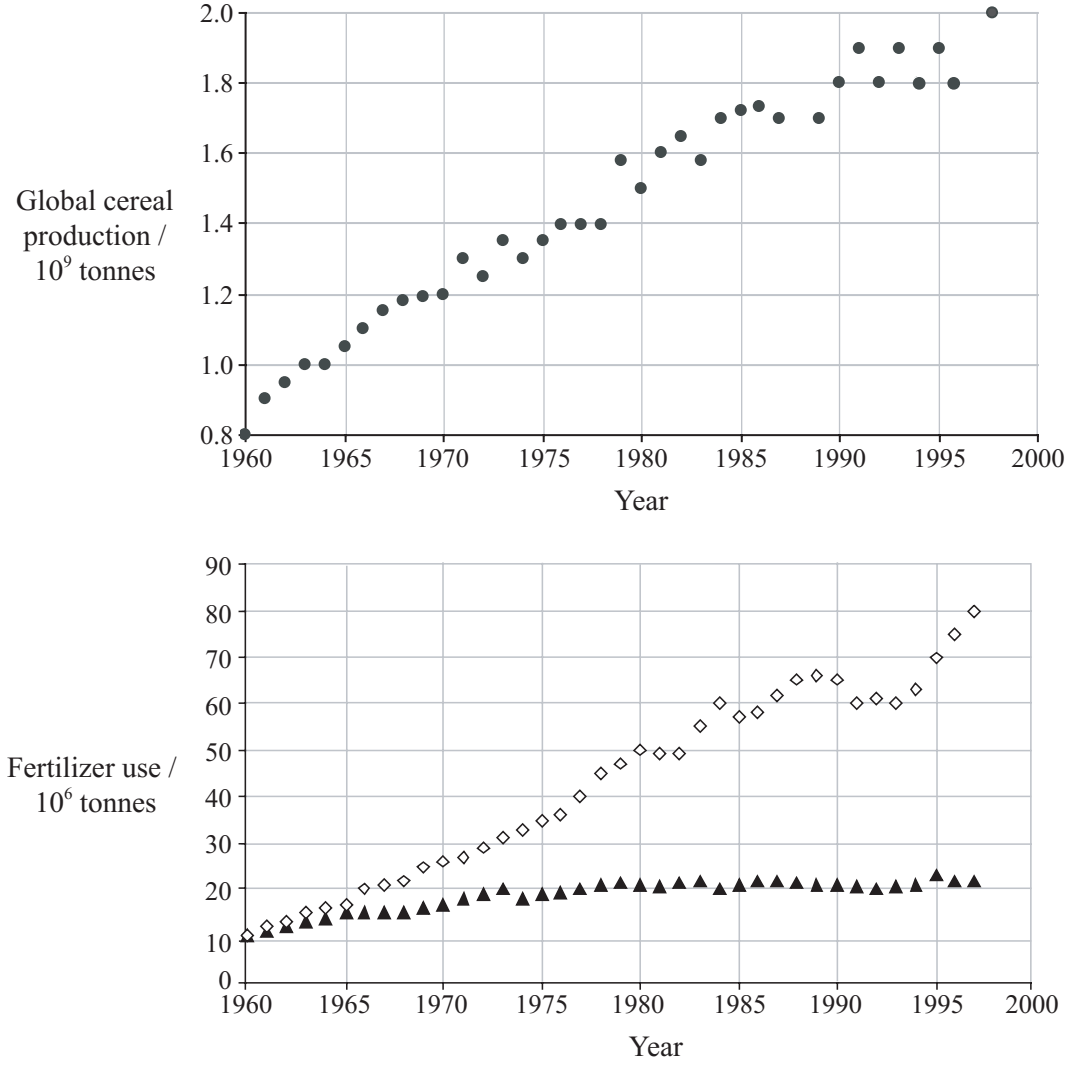
Option F — Applied Plant and Animal Science

F1. The supply of agricultural products and the maintenance of the environment are both essential for human existence and quality of life. The scattergraphs below show trends in global cereal production and in the use of phosphorus and nitrogen fertilizers over the past forty years.



(a) Identify the amount of phosphorus and nitrogen fertilizer used in 1980. *[1]*

Phosphorus: . . . . . .

Nitrogen: . . . . . .

(b) Calculate the percentage increase in global cereal production from the year 1960 to 1990. *[1]*

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(This question continues on the following page)

(Question F1 continued)

(c) Discuss, using the data, the relationship between the use of phosphorus and nitrogen fertilizers and global cereal production. *[3]*

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(d) Explain **two** disadvantages of the use of chemical fertilizers. *[2]*

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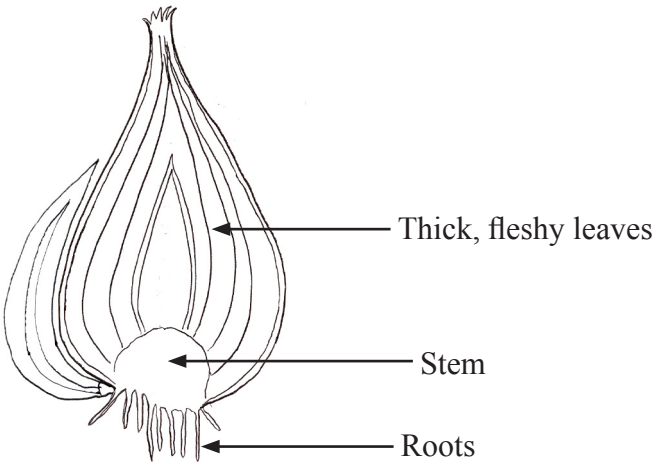
F2.



(a) State which type of reproduction is shown in the diagram above. *[1]*

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(b) Define the term *polyploidy* and state **one** example. *[2]*

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F3. (a) Discuss the use of antibiotics in livestock production and the ethical issues that might arise. *[6]*

(b) The shoot tips of plants produce auxins. Describe the role of these auxins in the control of growth and what occurs within a plant after a gardener has pruned off the shoot tips. *[4]*

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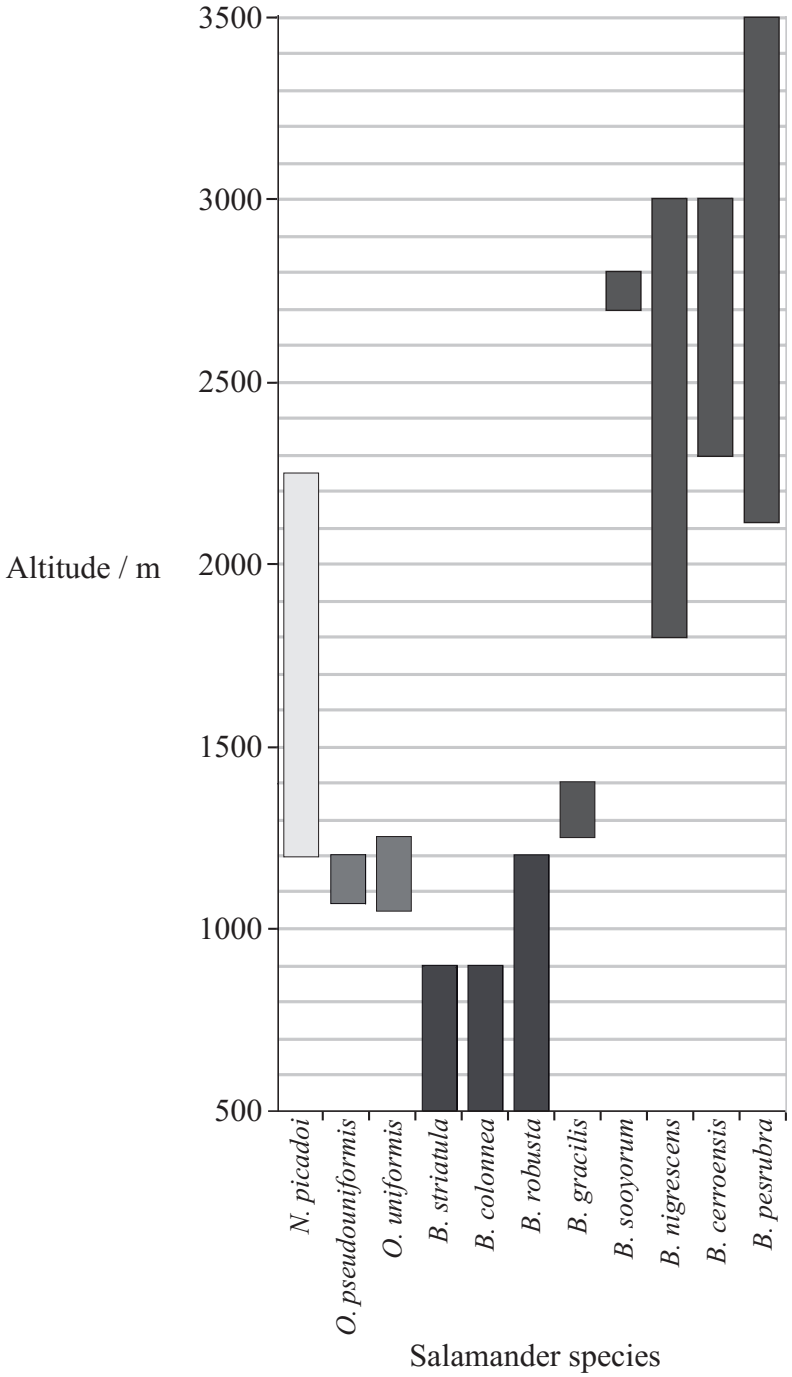
Option G — Ecology and Conservation

G1. (a) Explain the function of chemoautotrophs in the nitrogen cycle. *[6]*

(b) Outline the chemical effect of chlorine on the ozone layer and how the use of CFCs as propellants has contributed to this process. *[4]*

G2. The biodiversity of Costa Rican salamanders was studied over a range of altitudes. The salamanders belong to three genera: *Nototriton*, *Oedipina and Bolitoglossa*. *Nototriton* includes very small animals (less than 40 mm), *Oedipina* has an average size of 60 mm and *Bolitoglossa* is a diversified genus including *B. pesrubra* which is less than 65 mm to *B. nigrescens* which is about 95 mm.



[Source: Garcia-Paris *et al.*, *Proceedings of the National Academy of Sciences*, (2000), **97**, pages 1640–1647, Copyright 2000 National Academy of Sciences, USA]

(This question continues on the following page)

(Question G2 continued)

(a) Identify the range of altitude at which *B. cerroensis* can be found. *[1]*

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(b) Identify the altitude at which the greatest diversity of salamanders can be found. *[1]*

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(c) Compare the distribution of *Bolitoglossa* and *Oedipina*. *[2]*

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(d) Evaluate the evidence provided by the data for altitude as a factor in the ecological niches of the salamanders. *[3]*

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G3. (a) Define the term *biomass*. *[1]*

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(b) State **two** *ex situ* conservation measures. *[2]*

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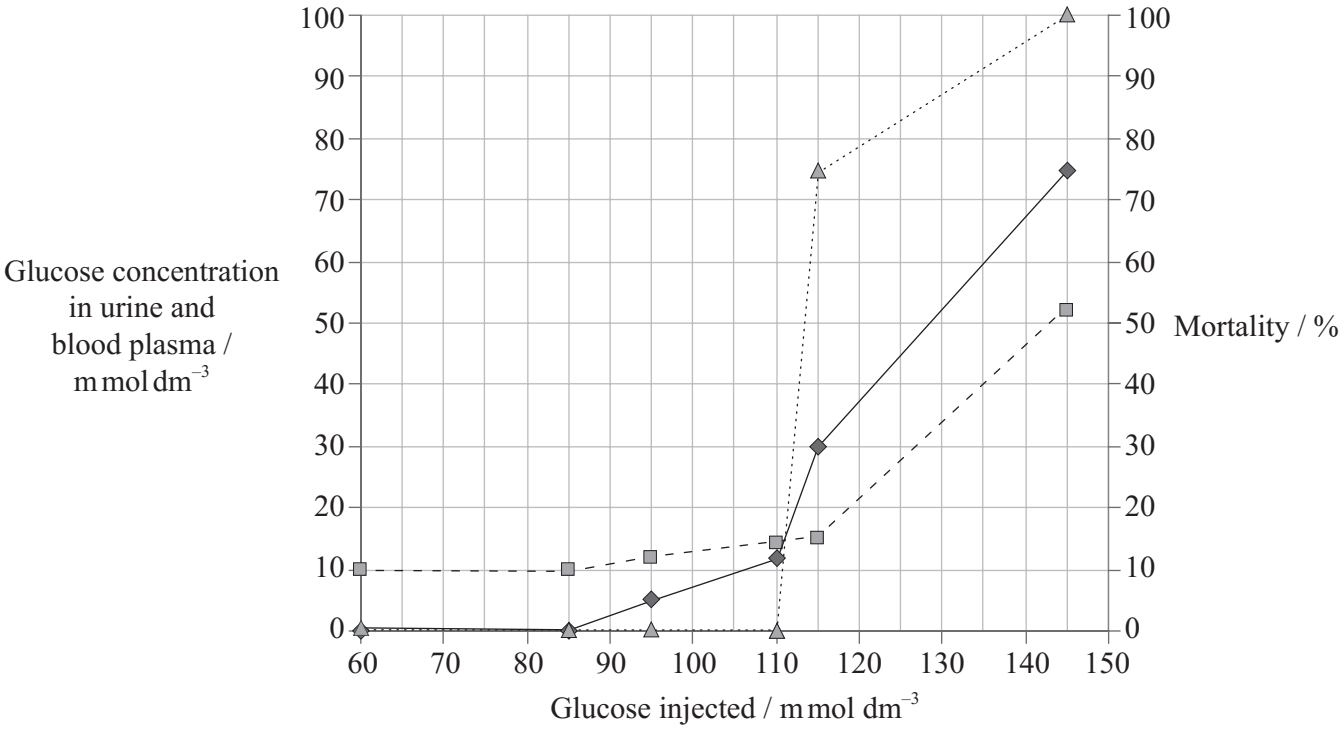
Option H — Further Human Physiology

H1. Intravenous nutrition is used in patients who cannot feed by mouth. Introducing nutrients directly into veins bypasses the rate at which the digestive system absorbs them. Scientists studied the effect of injecting six different glucose concentrations into rats. They measured the glucose concentration in the urine per day and the glucose concentration in blood plasma per day. These values were compared to control rats that received the same six glucose concentrations through the mouth. The percentage of rats that died during the experiment (mortality) was measured. The results for all control rats orally fed with six different glucose concentrations were the same and are shown in the table below.

Urine glucose concentration / m mol dm^{-3}	**Blood plasma glucose concentration / m mol dm^{-3}**	**Mortality / %**
0	10	0

The results for the injected rats are shown in the line graph below.



(a) State the mortality for rats when injected with 110 m mol dm^{-3} glucose. *[1]*

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(This question continues on the following page)

(Question H1 Continued)

(b) Estimate the difference in blood plasma glucose concentration between rats injected with 145 m mol dm^{-3} glucose and the blood plasma glucose concentration of control rats orally fed 145 m mol dm^{-3} glucose. *[1]*

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(c) Using the data, explain the conclusions that can be drawn about the ability of the rats to regulate blood plasma glucose levels successfully. *[3]*

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(d) Suggest reasons for the differences between rats that were injected and the rats that were orally fed high levels of glucose concentrations. *[2]*

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H2. Outline **one** possible cause of asthma and its effect on the gas exchange system. *[3]*

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H3. (a) Outline how the contraction of the atria and the ventricles is controlled. *[4]*

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(Question H3 continued)

(b) Explain the control of thyroxin secretion. *[6]*